

Safe Handling of Acids and Bases

General Hazards

This supplement outlines the basic safety practices to follow while handling acids and bases (Table 1) and is intended for people not normally familiar with acid and base properties.

Most acids are liquids, and most bases are solids. Acids, especially when in concentrated form, are most likely to cause immediate pain when they contact the body. Contact with strong bases, on the other hand, usually goes unnoticed since immediate pain does not occur. This allows the base time to react with the body part, and a serious injury may result.

Solid bases, when dissolved in water, can cause serious damage to eyes and skin by their corrosive action. Fine dust from almost any solid base can cause severe damage to the eyes, upper respiratory tract, and lungs. Fine dust can also cause skin irritation, particularly to persons who have become wet or perspire freely.

All of these materials are corrosive and will destroy body tissue. The seriousness of the injury depends on such factors as the type and concentration of the chemical, the body parts contacted, and the speed used in applying emergency measures.

In general, the hazards are:

- *Skin contact*- Most concentrated acids and bases are corrosive and must immediately be flushed with water. Eyes are especially susceptible to liquids, vapors, dusts, or mists and must be immediately flushed with water if exposure occurs. (See the section on first aid.)
- *Inhalation*. Vapors, mists, and dusts act on the body in two ways: irritation of the air passages of the nose, throat, and lungs and absorption of the substance from the lungs into the blood stream. The seriousness of injury will depend on the concentration in air and on the duration of exposure.
- *Ingestion*- Ingestion causes severe burns of the mucous membranes of the mouth, throat, esophagus, and stomach.
- *Fire or explosions*. Concentrated aqueous solutions of inorganic acids are not in themselves flammable. Combustion can occur, however, when an acid is mixed with other chemicals or with combustible materials. Acids also react with many metals, resulting in the liberation of hydrogen, a highly flammable gas. Some acids are strong oxidizing agents and can react destructively and violently when in contact with organic or other oxidizable materials.

TABLE 1. Materials commonly used at LLNL.

Acids	Bases
Nitric acid— HNO_3	Ammonium hydroxide— NH_4OH
Sulfuric acid— H_2SO_4	Sodium hydroxide— NaOH
Hydrochloric acid— HCl	Lithium compounds
Hydrofluoric acid— HF	Potassium hydroxide— KOH
Phosphoric acid— H_3PO_4	Lime (hydrated and dehydrated)— $\text{Ca}(\text{OH})_2$, CaO

Personal Protective Equipment

Each supervisor must evaluate the chemical handling procedures in his area and require personnel to wear appropriate personal protective equipment. In all cases, wearing safety glasses is the minimum requirement. Supervisors are encouraged to call for help from the Hazards Control Safety Team for technical assistance in this evaluation.

When complete body protection is needed, the following items should be worn:

- A full-face shield with chemical goggles worn underneath.
- A full-face mask with an organic vapor/acid gas canister if respiratory protection is needed. (Contact a member of the Hazards Control Safety Team to obtain the proper equipment.)
- Rubber or neoprene gloves to protect hands and arms. Be sure the glove material is suitable for the material being handled.
- A full-body-length rubber, plastic, or neoprene apron appropriate for the material being handled.
- Shoes of all-leather upper construction, rubber boots, or other equipment giving full-foot protection.

Labeling

Under no condition should acids or bases be stored or used in *unmarked* containers. All containers must be labeled clearly, concisely, and in simple, easily understood terms. Standard adhesive-backed labels are available at Stores (stock Nos. 4280-46521 and 4280-46522).

The following information must be included on all containers if standard labels or original manufacturer's labels are not available:

- *Name of Material.* This should include the chemical name and strength. The trade name, where applicable, may also be included.
- *Signal Word.* The word should designate the approximate degree of hazard—for example, DANGER, WARNING, CAUTION.

Labels must be protected so that they will remain intact and legible. A label should be replaced whenever any portion becomes illegible.

Storage Areas

The corrosive properties of these materials and their ability to produce fires or explosions by combination with combustible materials make the following considerations mandatory in the selection of a storage site:

- A relatively cool, dry environment free from extremes of temperature and humidity should be maintained.
- Acids and bases should be stored in a manner that separates them from other materials and from each other. Each acid or base should be stored in a manner consistent with its properties.
- When stored, small containers (approximately 1 gal or less) should be placed on material that is acid-resistant; this facilitates flushing and other cleanup procedures in the event of leaks or spills.
- Carboys (approximately 5 gal) should be stored in the same manner as small containers—that is, preferably covered, not stacked on one another, and on acid-resistant material.
- All drums (approximately 55 gal) should be stored on individual racks or securely blocked on skids with the closure (plug) facing upward to prevent leakage. Drums containing acids in liquid form should be vented when received (and at least weekly thereafter) to relieve accumulated internal pressure.

These measures do not in any way eliminate the necessity for good housekeeping and for continual inspection of containers.

Handling

Safe-handling procedures will vary with each operation and type and concentration of the chemical, but the following general safe-handling methods are applicable:

- Never pour water into acid. Slowly add the acid to the water and stir.
- Never empty carboys or drums of chemicals by means of air pressure. Use a tilting rack, a safety siphon, or a liquid pump.
- Never siphon by means of hose and mouth.

- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes and fumes.
- Flush the outside of the container with water after use to clean off any droplets of material.
- When disposal containers are completely emptied of their contents, flush them thoroughly with water before throwing them away.
- An eyewash should be located in all areas where acids or bases are used. Safety showers should be nearby if significant acid or base quantities are involved. Hazards Control will assist in evaluation of need and location.
- Never mix acid wastes with materials such as solvents, metal-contaminated solutions, etc. (explosions can result).
- Work in areas with enough ventilation to prevent accumulation of fumes.
- Never dispose of more than 100 ml (about 3 oz) of acid or base in the sanitary sewer system. When disposing of smaller amounts, pour slowly and flush with plenty of water.

Spills

Don't use combustible organic materials--sawdust, excelsior, wood scraps and shavings, paper, rags, or burlap bags for example--to absorb or clean up spills. Do use the appropriate following action(s):

- Evacuate people from the area.
- Establish the best possible ventilation.
- Isolate the area.
- Call for assistance: dial the Laboratory emergency number (2-7333).
- Outside cleanup. If a spill occurs outdoors in an area with good drainage, it can be allowed to drain after being diluted with large volumes of water. Carefully dilute with at least 10 times the spilled volume. (Refer to Disaster Control Plan Supplement No. 18, *Hazardous Materials Spill Plan*.)
- Inside cleanup. If a spill occurs indoors or in an area where it is undesirable to use large quantities of water for dilution, neutralize the solution by using powdered sodium bicarbonate (for acid spills) or a 10% mixture of hydrochloric acid and water (for liquid base spills). Apply small amounts of the neutralizing mixture, starting at the edges and moving inward. Do not dump large quantities of the neutralizing material on the spill: a violent reaction may occur. Dry spills of bases should be handled by picking up the solid using a shovel, scoop, or rubber gloves. Remaining powder may be handled by adding water and the 10 hydrochloric acid, as described above.

Waste Disposal

Segregate organic acids, inorganic acids, and bases. References such as the NFPA *Fire Protection Guide on Hazardous Materials* and the CMA's *Guide for Safety in the Chemical Laboratory* are good references for chemical incompatibilities. All waste must be appropriately packaged for on-site transportation. Contact the Hazards Control Health & Safety Technician assigned to your area when you have quantities of acids or bases to discard. Unidentified waste will not be accepted.

First Aid

Eye

- *Immediately* flush the eye with clean tap water (flush the eye before other parts of the body) and dial the Laboratory emergency number (2-7333). Report the incident--an ambulance will be dispatched.
- Spread the eyelids with fingers, and allow water to flood the eye. Roll the eye about so that the water may contact all surfaces. Use nothing but clean water, and use plenty of it.
- Continue washing the eye with clean tap water until medical aid can be obtained.

Skin Exposure

- Flush the exposed area thoroughly with plenty of clean water; remove contaminated clothing, and then gently flush the area again with water.
- Report to the Medical Department for treatment as soon as possible.

Swallowing

- Follow all instructions on the container label.
- Dial the Laboratory emergency number (2-7333) and report the incident--an ambulance will be dispatched. Save the container for Medical personnel.

Bulk Operations

Dip tank or similar bulk operations can only be performed under the following minimum requirements:

- The area and design must be reviewed by the Hazards Control Safety Team for the area. It is the responsibility of the supervisor who desires to establish an acid or base handling area to obtain a Hazards Control review of the proposed operation before installation.
- Eyewash and emergency shower facilities must be installed in close proximity.
- Adequate ventilation must be provided for the operation (it must meet the ventilation requirements established by the Hazards Control Industrial Hygiene Group).
- All dip tanks must be properly labeled.
- Dikes or berms may be required if a tank failure would expose personnel or equipment to the acid or base solutions.
- The dipping of copper plates or copper flex hoses into nitric acid dip tanks can be potentially dangerous; nitrogen dioxide gas, reddish brown in color, is emitted when copper metal reacts with nitric acid. The quantity of nitrogen dioxide gas depends on how much copper there is and how long the metal is in the acid bath. Exposures of relatively short duration to concentrations above 5 ppm produce coughing and irritation of the respiratory tract. Continued exposures to concentrations much above 5 ppm may produce a slowly progressive and sometimes fatal pulmonary edema and hemorrhage. High concentrations irritate mucous membranes and wet skin surfaces. Atmospheric concentrations above 50 ppm are immediately hazardous to life or health.

Transportation and Shipping

See Chapter 8 of the *Health and Safety Manual* for guidance on transportation and shipping of these corrosive materials.